

Designing Effective/Affordable System Upgrades & Process Improvements for Legacy Aircraft

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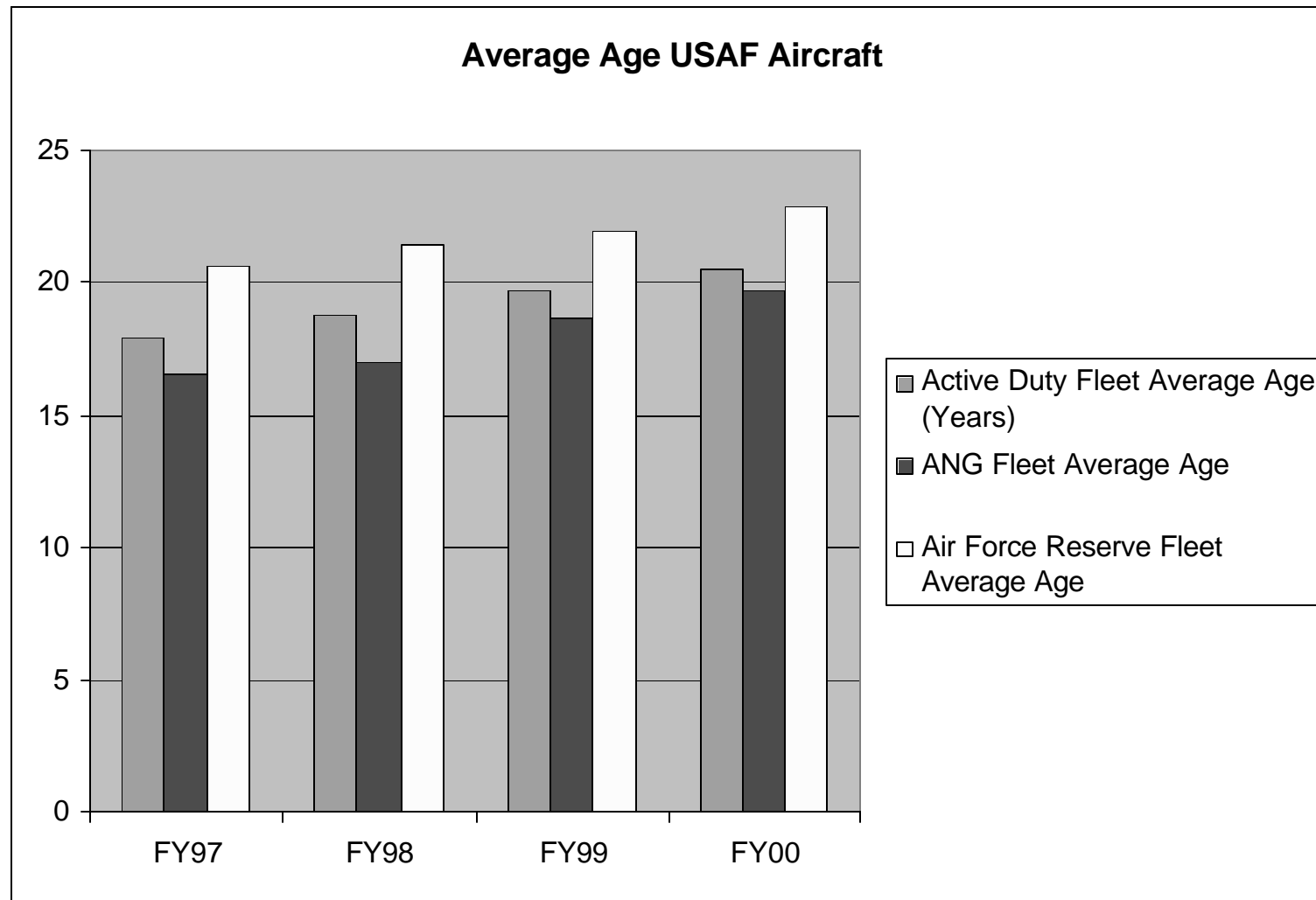
Overview

- Background
- Modular Open Systems Approach
- Economic Analysis
- Alternatives
- Conclusions

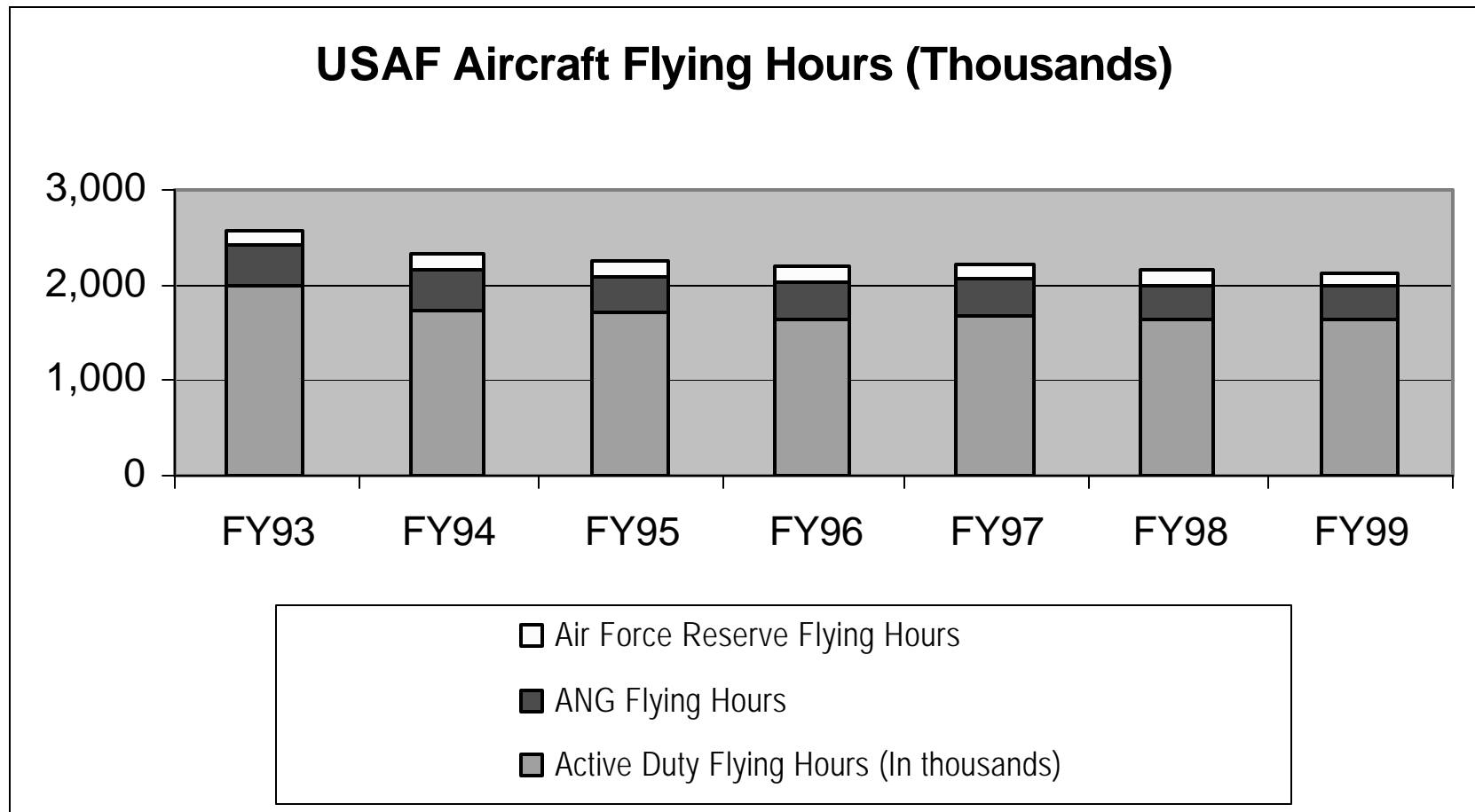
Background

- Number of new weapon systems in development is at its lowest point since WW II
- New aircraft procurements for USAF are averaging less than 30 per year
 - At this rate, it will take 200 years to replace the fleet
- 55 USAF aircraft are lost per year to accidents

Aircraft fleet age and avionics age increasing

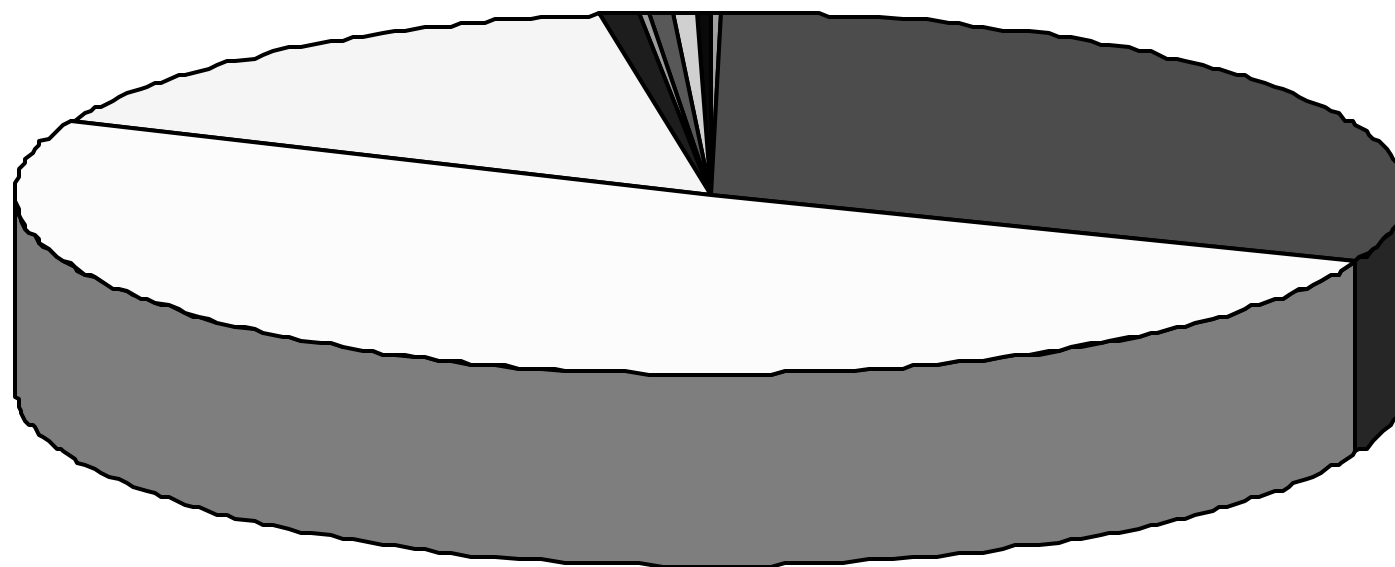


Aircraft flying hours are decreasing

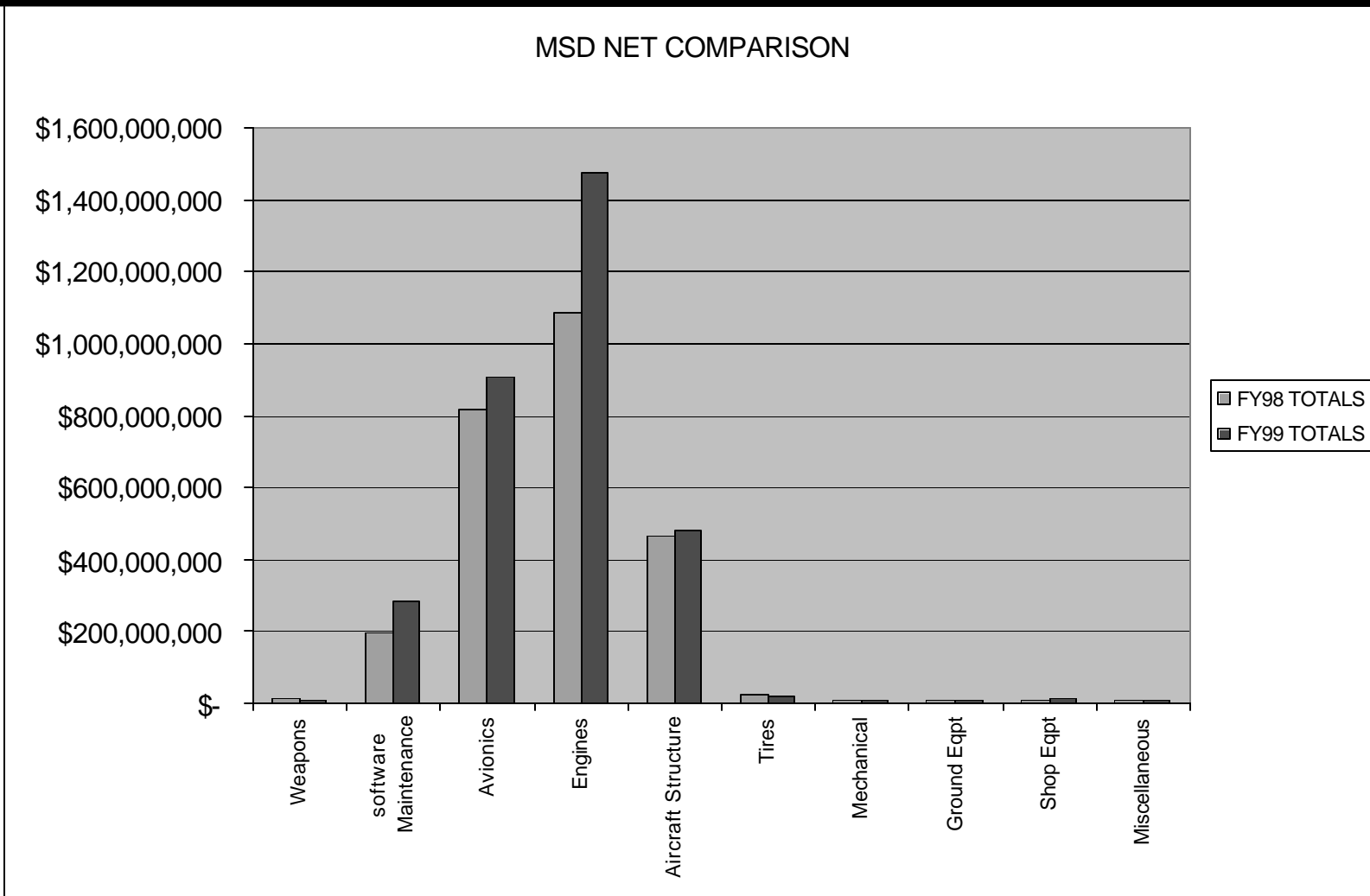


Aircraft Hardware Cost Drivers

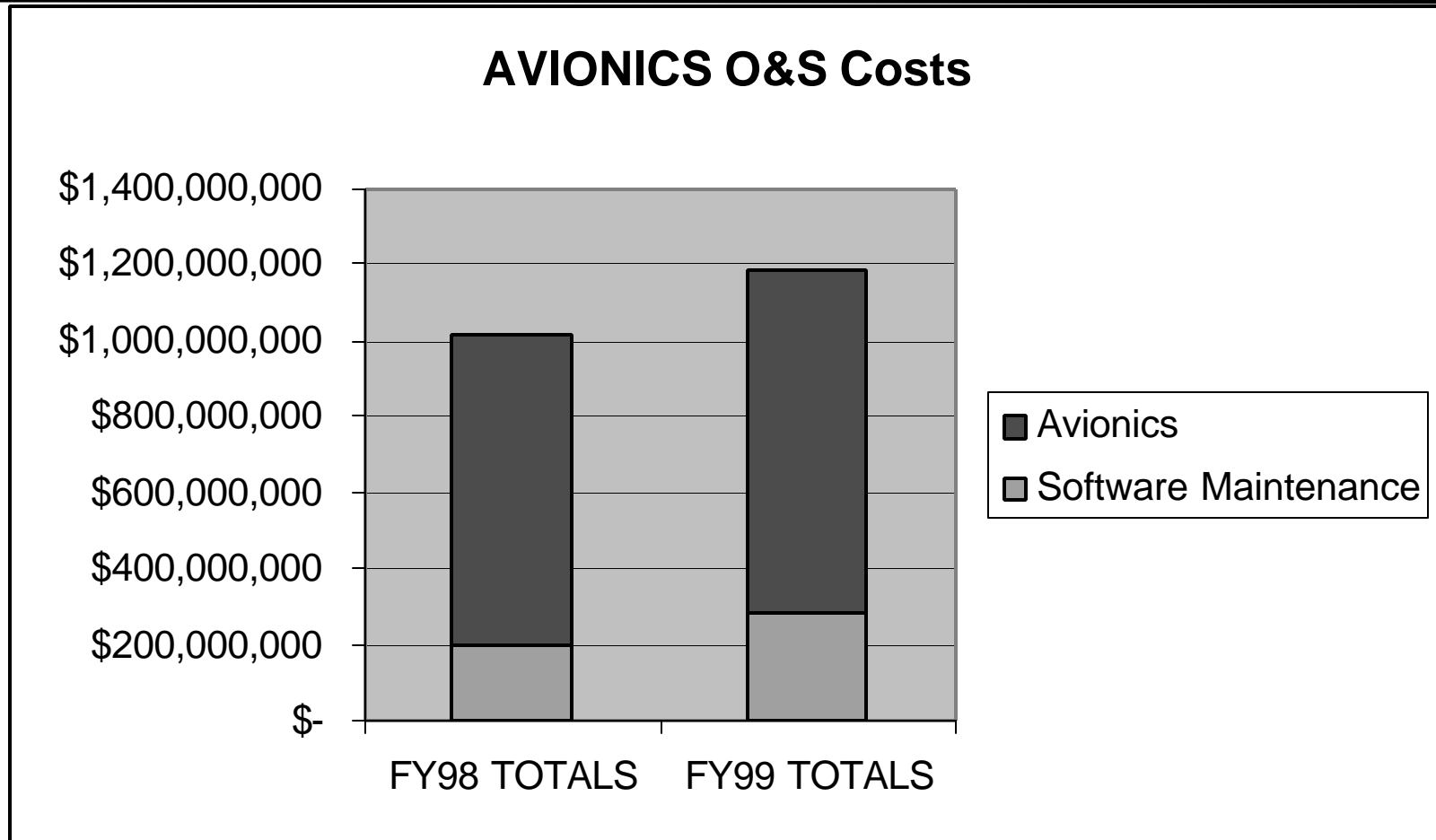
FY99 MATERIAL SUPPORT DIVISION NET COST



Aircraft O&S costs are increasing



Avionics O&S costs are increasing



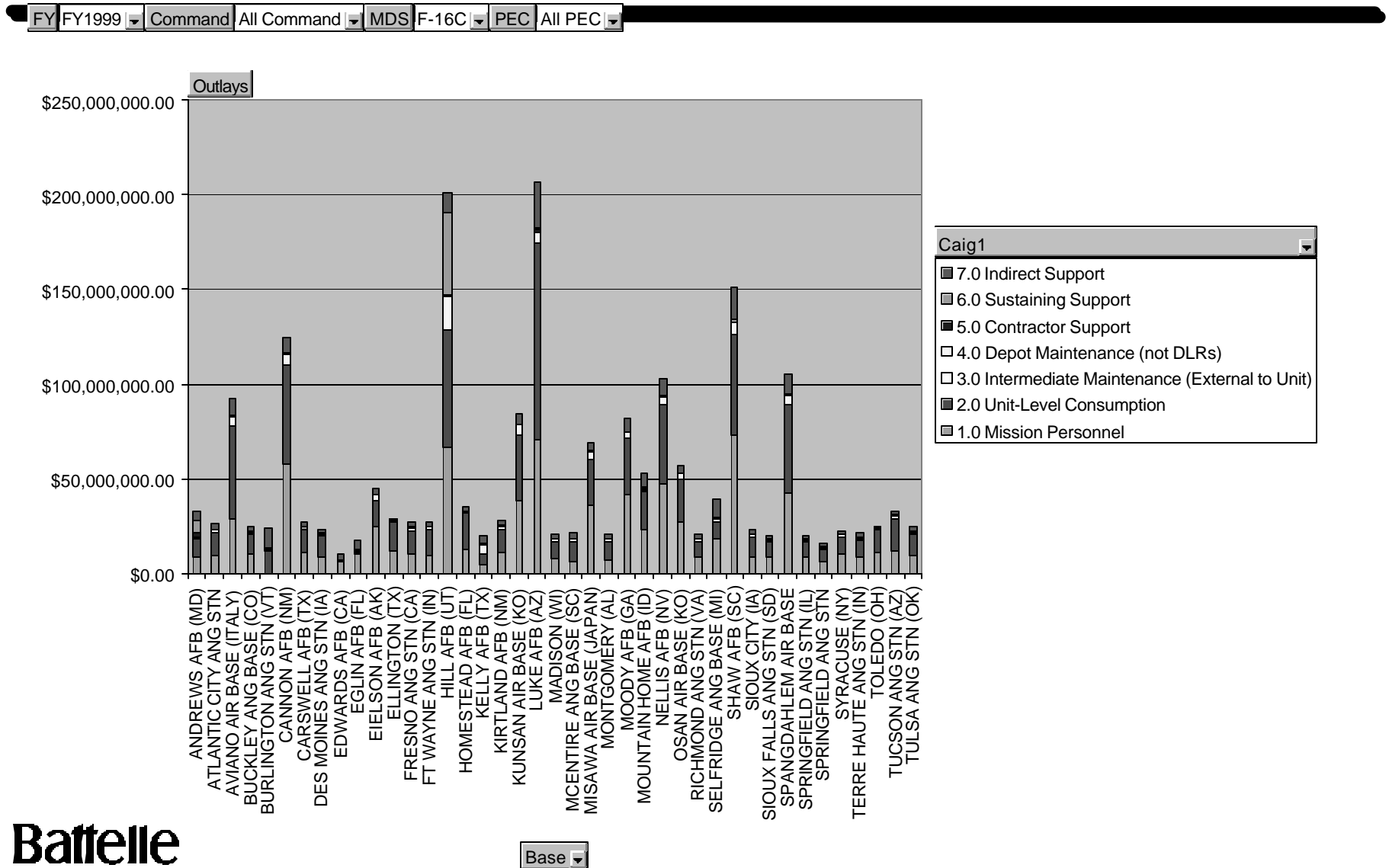
Total Ownership Cost (TOC) Drivers

- Personnel
- Unit Level Consumption
 - Fuel
 - Consumables
 - Depot Level Reparable (Material Support Division)
- Intermediate Maintenance
- Depot Maintenance
- Contractor Support
- Sustaining Support
- Indirect Support

TOC Reduction Alternatives

- Personnel – Number of aircrews per aircraft is below the required number; maintenance personnel are leaving for higher paying jobs in industry
- Unit Level Consumption
 - Fuel savings are hard to achieve on existing aircraft with existing engines
 - Consumables are things that are used and thrown away as they wear out
 - MSD items can be replaced with newer technology if funding is available
- Intermediate maintenance cost is low relative to other costs
- Depot maintenance costs for aircraft going through programmed depot maintenance are growing as fleet ages
- Contractor support costs are growing with move to Total System Program Responsibility
- Sustaining support includes software and purchased equipment
- Indirect support includes indirect civilian and military personnel, health, etc.

Total Ownership Cost-CAIG format



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TOC reduction is dependent on MSD cost reduction

- Identify high TOC parts
- Define requirements for replacement
- Define alternatives
 - Candidate Technology
 - Acquisition and Operating and Support Scenarios
- Perform economic analysis to determine funding by FY, ROI, and payback
 - Investment costs can be kept low by use of Commercial of the Shelf (COTS) items

The Air Force Computer/Display Problem

- **Current support costs**
 - Fighter/Bomber annual cost of \$13+M
 - HUD costs > \$13M
 - Support Equipment costs unknown
 - Software costs unknown
- **Lack of growth options for GATM, Datalink, RTIC, etc.**
 - No solid ties to the commercial market
- **Vanishing suppliers - (DMS Problem)**
 - Example - No B-52 AN/ALR-20 CRT Makers in the world
 - Flat panel vendors quit the military market
- **Too many point designs**
 - Large logistics tail with many different items (Acft. & Support Equip.)
 - Expensive development if each MDS design done independently

Recent Studies & Write Ups

- **DOIPT Study on Display Acquisition (Just released) - 18 Jan 00**
 - Current Situation Assessment: (Item 6. Page 7)
“Few display integrators currently employ an open systems approach despite the potentially significant life cycle benefits of open systems”

- **Bomber White Paper**
 - Page 5 - Future Modernization
“Technology and new tactics built around information superiority add a new dimension to SA (Situational Awareness) and survivability. fusing off-board and on-board information provides the crew with a complete battlefield picture that significantly increases lethality and survivability”

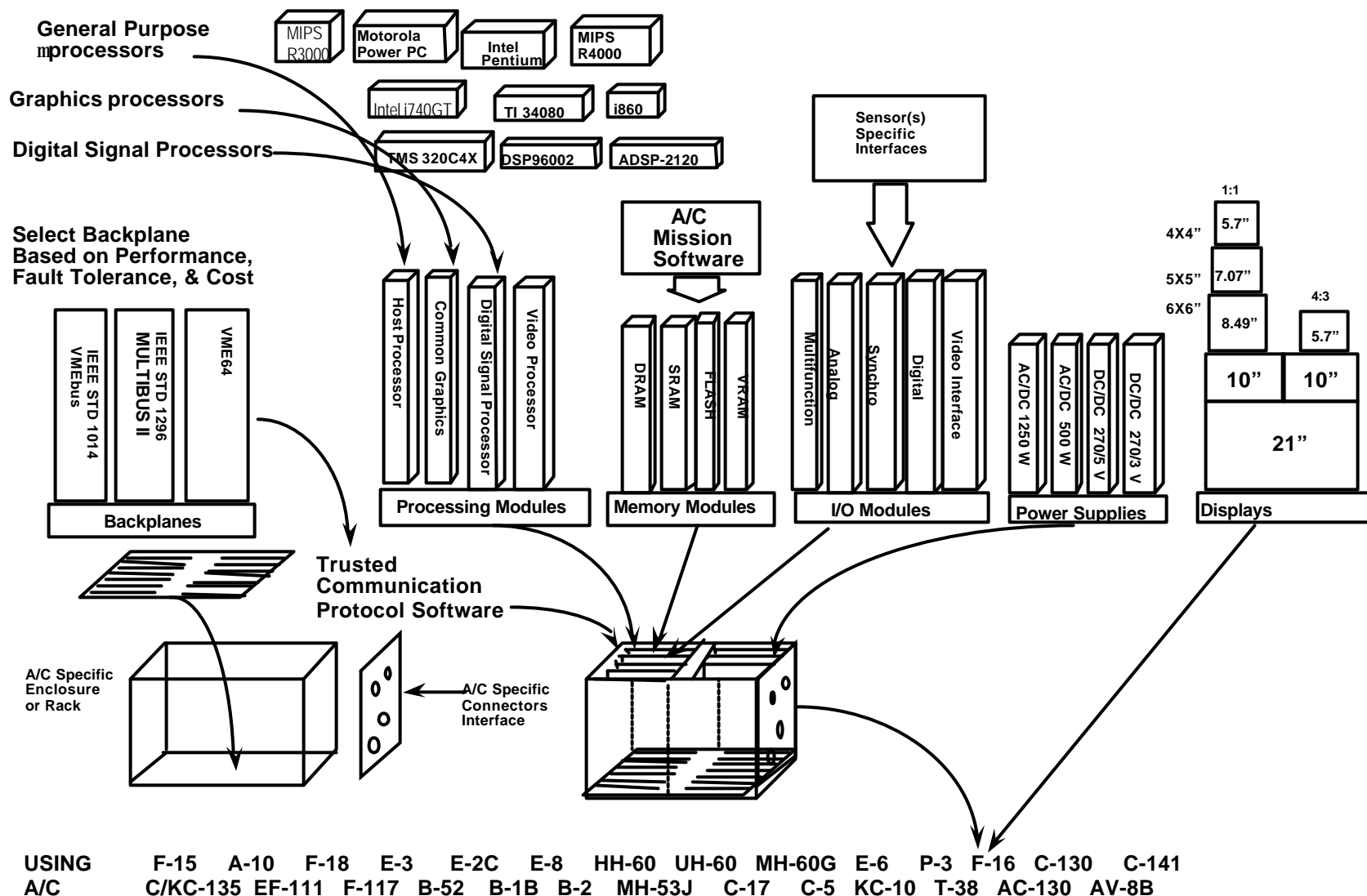
Air Force Options for the Next Decade

- Continue point designs (Each SPD does their own thing)
- Build a standard military system
 - (Tried with F-22, Comanche, and A-12)
- Build on COTS (Ruggedized as required)
 - Open systems
 - Commercial Standards
 - Commercial Software

Modular Open System Approach - How to Achieve Upgradeability & LCC Effectiveness

- Understand the current & potential requirements
 - Build I/O maps for the entire Fighter/Bomber force
- Modular Open Systems Approach (MOSA)
 - Use standard well defined interfaces
 - electrical, mechanical, software, protocol
 - Eliminate proprietary point designs
- Commercial Off The Shelf (COTS) technology
 - Leverage large base of commercial technology
 - Hardware & software
 - Ruggedize for military environment
- Modularity
 - Partition system functionality to logical building blocks
 - Simulate design to verify correct operation of system with other retained legacy systems

Choices for Avionics Retrofits Using Common Avionics Modules and Displays



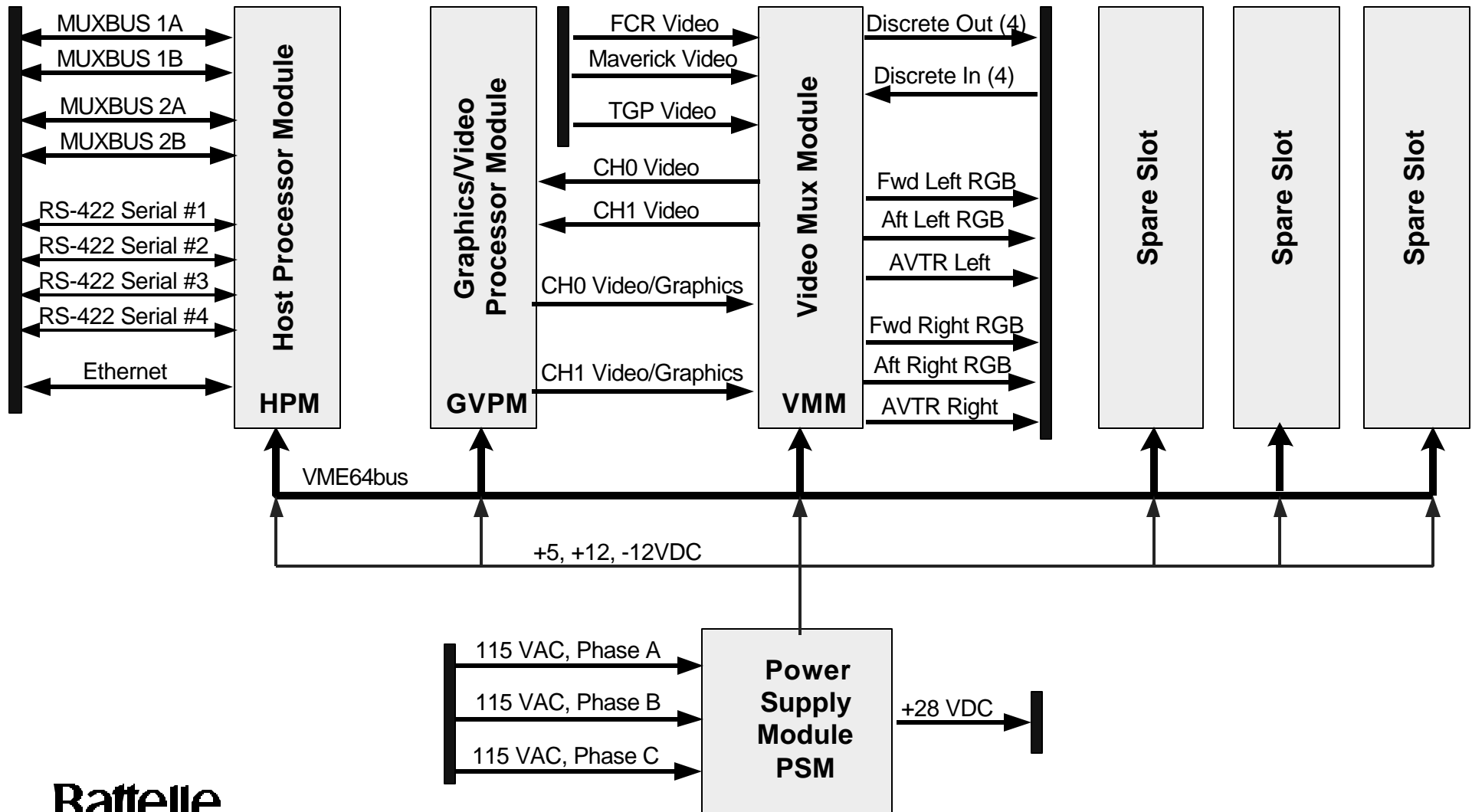
Potential for Commonality

	A-10	B-1	B-2	B-52	F-15	F-16	F-117
Backplane bus(s)	Common	Common	Common	Common	Common	Common	Common
Graphics processors	Common	Common	Common	Common	Common	Common	Common
Microprocessors	Common	Common	Common	Common	Common	Common	Common
Memory modules	Common	Common	Common	Common	Common	Common	Common
Displays	Family	Family	Family	Family	Family	Family	Family
Power supplies	Common	Common	Common	Common	Common	Common	Common
Software protocols	Common	Common	Common	Common	Common	Common	Common
Avionics Video Interface Module	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Examples of Selected Approach

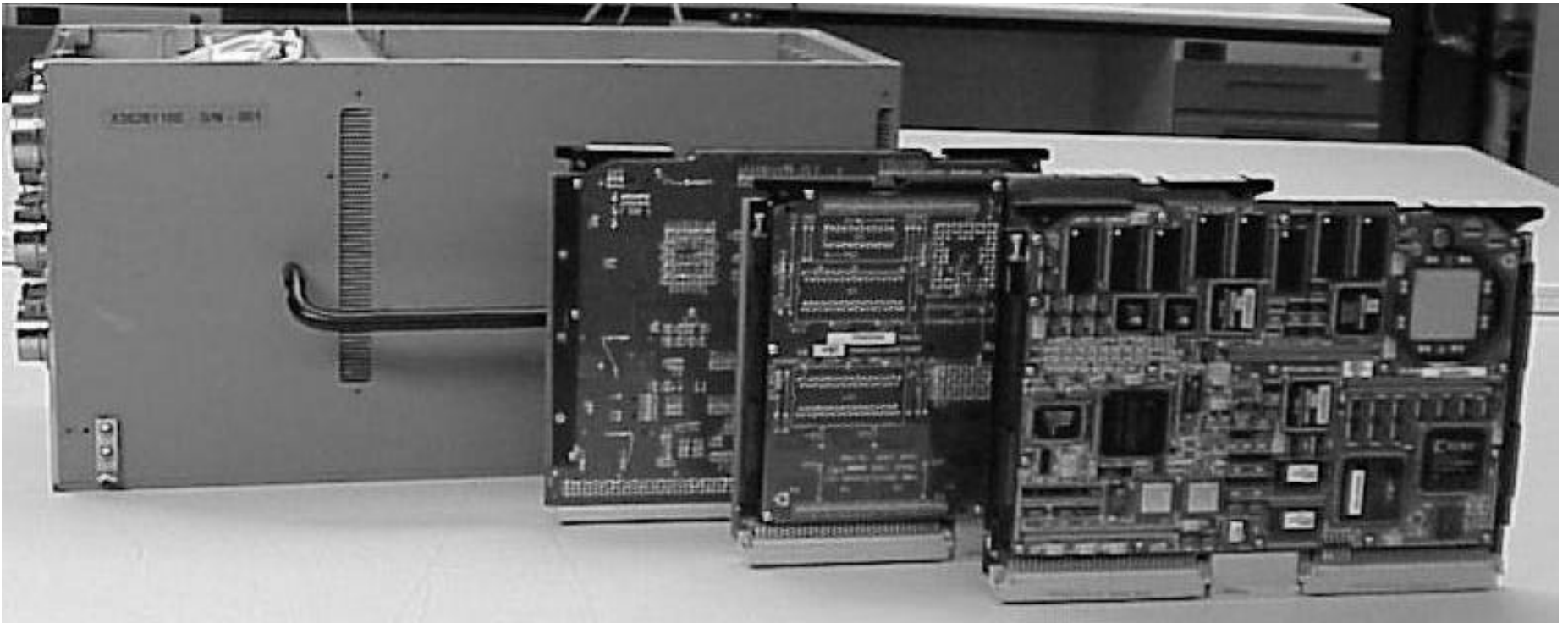
- F-16 Programmable Display Processor (PDP)
- A-10 Digital Stores Management Program
- Common Large Area Display System (CLADS)

F-16 PDP Internal Architecture



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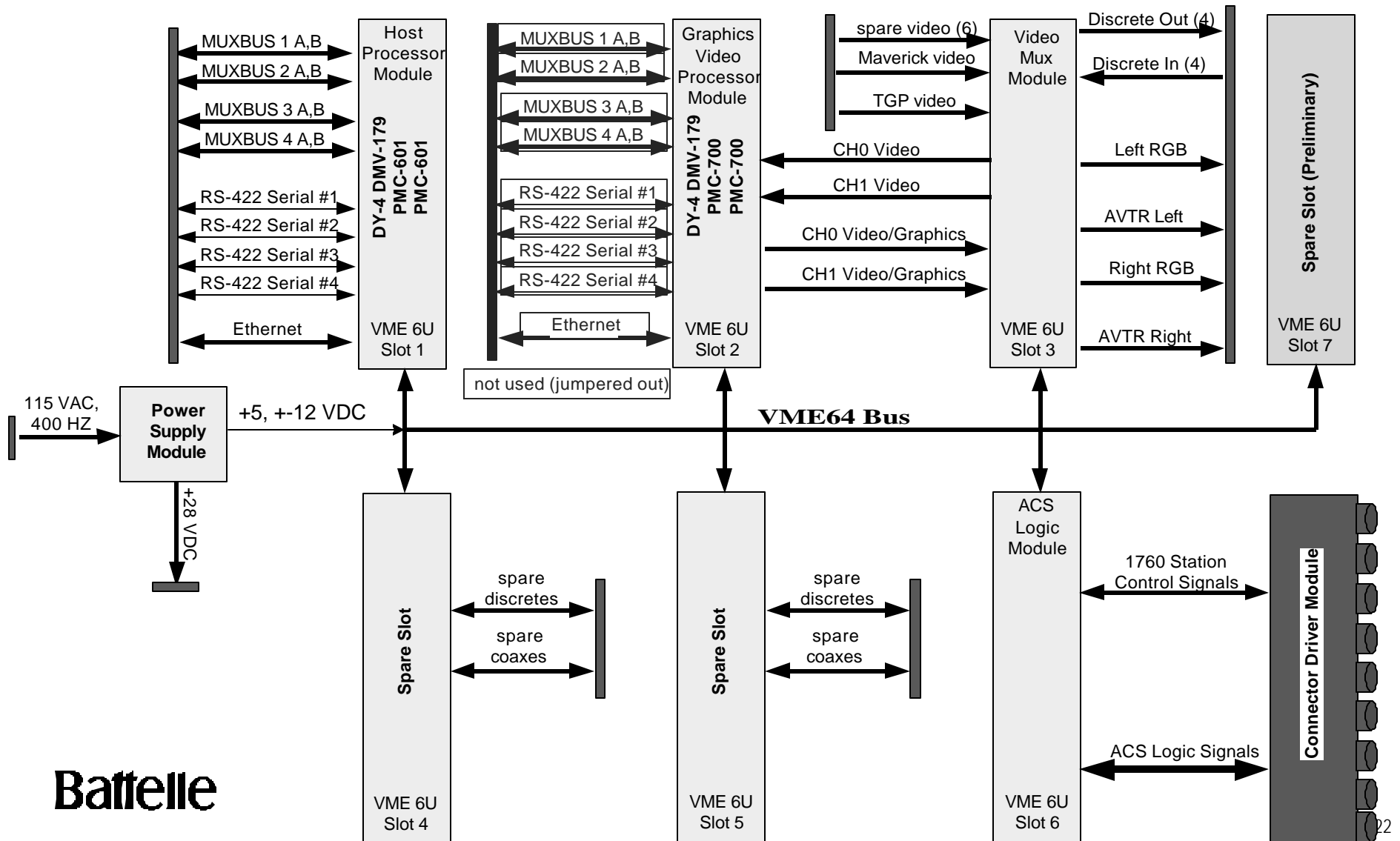
F-16 Programmable Display Processor



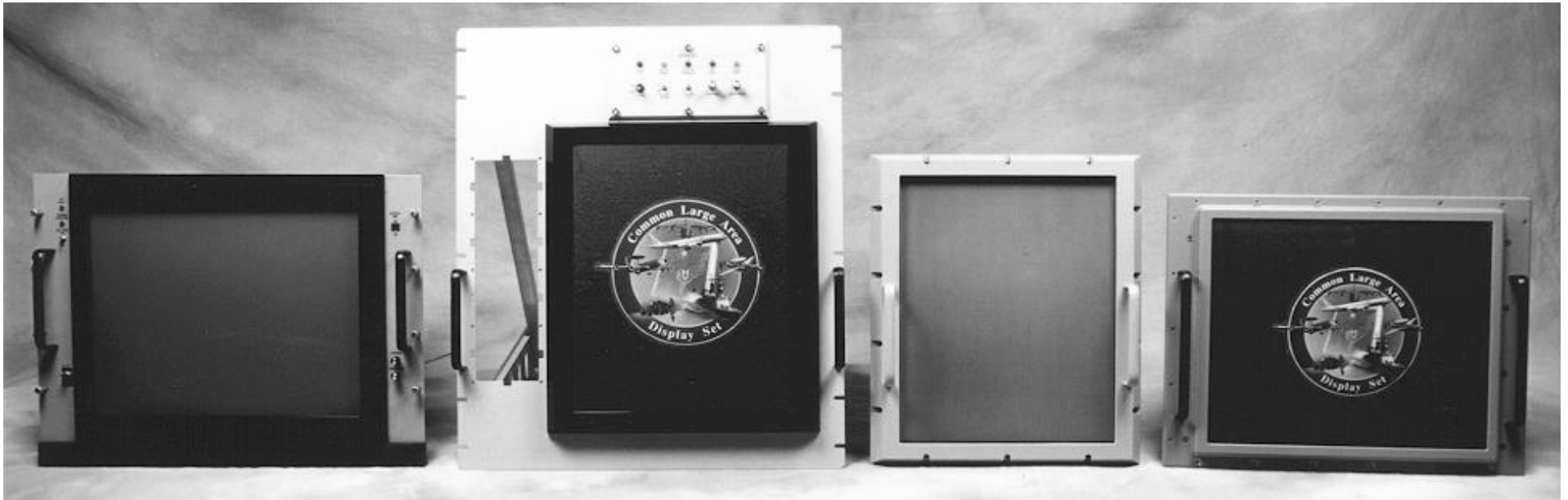
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A10 DSMS Generation 1

Implemented with Permedia3, PMC video cards



Common Large Area Display Set



Joint STARS
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ABCCC

E-3

E-2C

Air Force Actions Required for Common Displays/Display Processors

■ Initiate a three part program

- 1. Study the AEF aircraft and determine the cost and operational benefits of using an modular open systems approach.
- 2. Prototype a shipset(s) for each of the AEF aircraft
- 3. Implement a common avionics display and display processor solution
- 4. Synchronize the timing of program upgrades

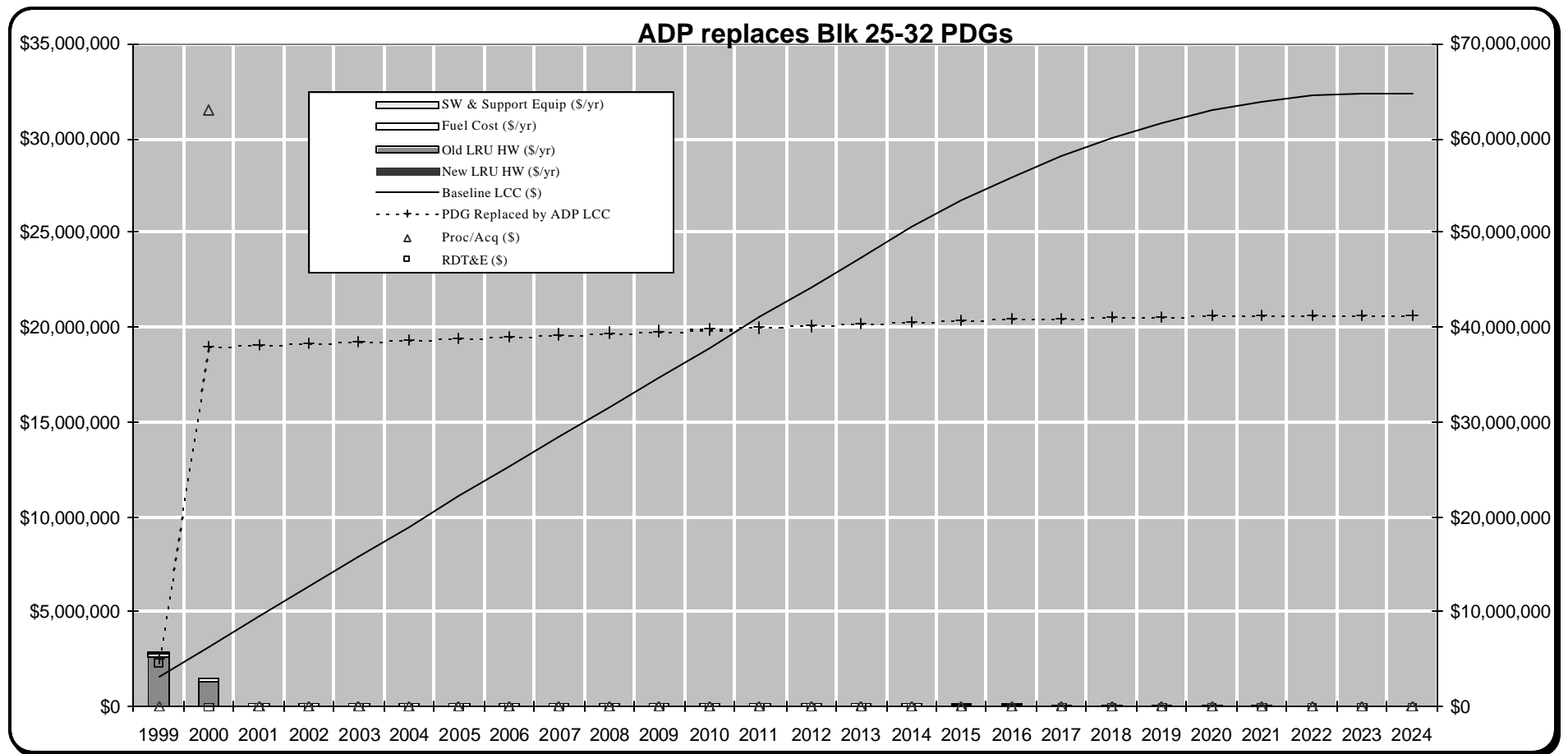
Economic analysis

- Baseline cost forecast
- Alternative cost forecast
 - Must include Development and Operating & Support Costs
 - Must include risk analysis
 - Technology risk
 - Schedule and funding risk
- Compute cash flow by fiscal year
- Determine payback period
- Determine return on investment (ROI)

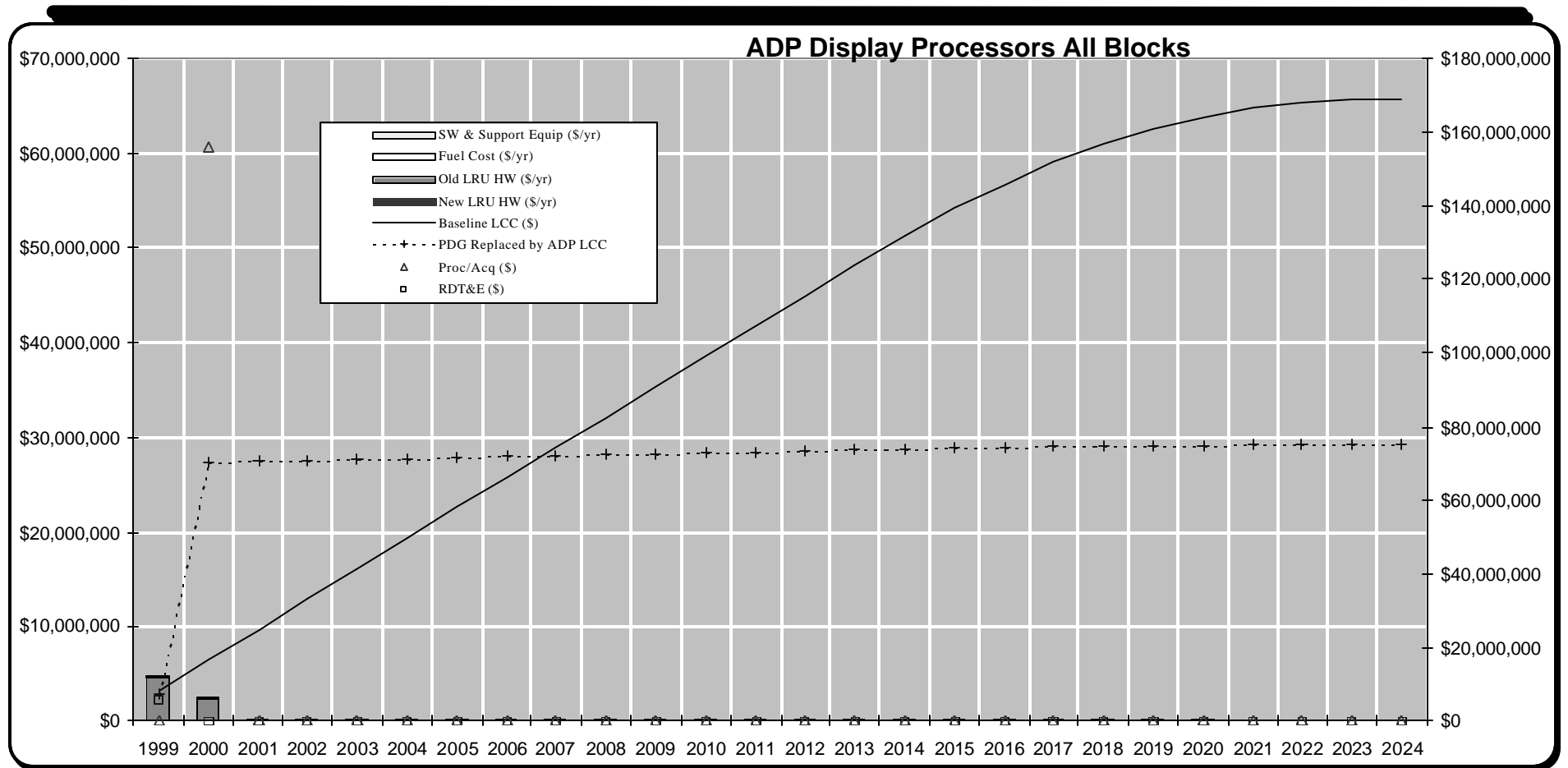
Candidate technology alternatives

- Must satisfy the requirements
- Parametric description of the candidate item
 - Weight
 - Power
 - Reliability
 - Logistics support plan
- Development and acquisition scenario
 - Development funding and time required
 - Acquisition funding and time required
 - Number to be acquired each year
 - Installation schedule

Result of one business case scenario



Result of changing scenario



Conclusions

- Legacy systems O&S costs will continue to increase
- Investment funds for development and acquisition are insufficient under current funding plans to have a significant impact on the increasing O&S costs
- Modular open systems approach using COTS provides the best opportunity with limited funding to achieve affordable upgrades
- COTS must include competition to get the best price, and minimize the time high TOC items remain in operation
- Focused upgrades striving to achieve greater commonality provide a larger buy with lower unit cost and higher ROI with a short payback